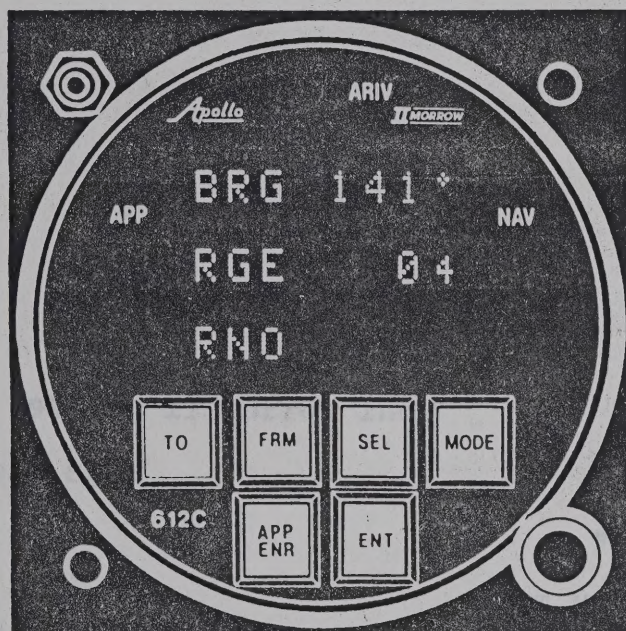


Apollo II

LORAN-C NAVIGATION SYSTEM
MODEL 612C

2310
415/16

INSTALLATION MANUAL



MORROW
INC.

SALEM, OREGON U.S.A.

MANUFACTURER OF QUALITY NAVIGATION AND COMMUNICATION SYSTEMS

0587

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INSTALLATION MANUAL

SECTION I

GENERAL INFORMATION

1.1 INTRODUCTION

This manual provides information about the electrical, mechanical, and physical characteristics as well as installation procedures for the APOLLO II Model 612C LORAN-C Navigation System by II Morrow, Inc. Follow the procedures recommended in this manual for successful installation and optimum performance.

1.2 EQUIPMENT DESCRIPTION

The APOLLO II Model 612C is a 3-1/4" square, panel mounted LORAN-C receiver as illustrated in Figure 1. Three screws secure the APOLLO II Model 612C to the instrument panel.

The FC-02 Low Level Flag Adapter and the A-16 LORAN-C Whip Antenna by II Morrow Inc. are included with the APOLLO II Model 612C package. The FC-02 is used to interface the APOLLO II Model 612C with CDIs that have separate TO/FROM and NAV VALID flags. The A-16 is the standard antenna and is rated to 350 kts (TAS). The A-17 LORAN-C High Speed Blade Antenna is rated to 521 kts (TAS). The A-23 LORAN-C Bent Whip Antenna is rated to 350 kts (TAS). The FC-02 is used to interface the APOLLO II Model 612C with CDIs that have separate TO/FROM and NAV VALID flags. The FC-01 may be used as the FC-02 and has the additional capability of providing a superflag output for an autopilot where required.

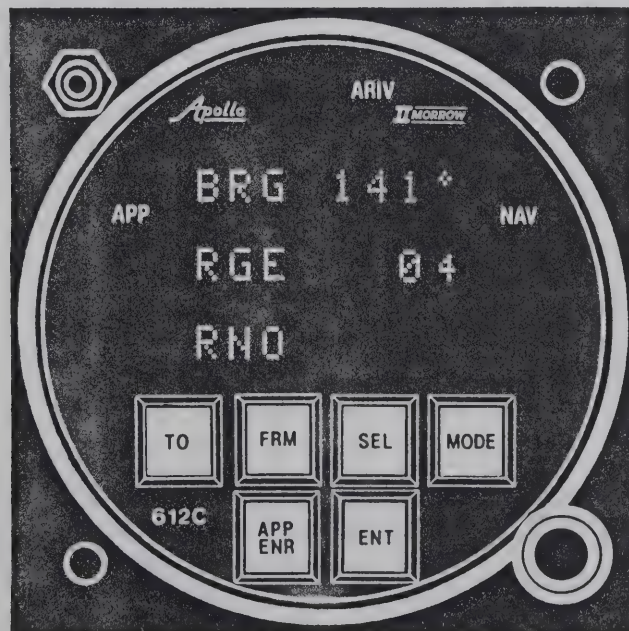


Figure 1

EQUIPMENT DESCRIPTION (cont.)

The APOLLO II functions as an area navigation device with position location derived by a LORAN-C receiver on the 100 kHz radio frequency transmitted by land-based stations. The APOLLO II enables the operator to utilize point-to-point navigation independently of terrain or altitude.

The APOLLO II package consists of the LORAN-C receiver, the mounting frame, and an antenna optimized for LORAN-C reception. The A-16 LORAN-C Whip Antenna is the standard antenna included with the APOLLO II Model 612C. The A-17 LORAN-C High Speed Blade Antenna and A-23 Bent Whip Antenna are available as options.

The APOLLO II using the FC-02 Low Level Flag Adapter can be interfaced with standard low level course deviation indicators (CDIs) and horizontal situation indicators (HSIs) with autopilot interface capability or with the FC-01 Superflag Adapter to autopilots requiring a superflag input.

The APOLLO II displays your present position in Latitude/Longitude coordinates, bearing and range to the destination or origin, track angle, ground speed in knots, cross track error, and estimated time enroute to your destination.

State-of-the-art, large scale integrated circuitry produces an extremely compact unit: size (H - 3.25", W - 3.25", D - 10.1"); weight - 3.5 lbs; with a nominal power consumption of 15 watts from an input voltage of 6.5 VDC to 48 VDC.

Additional features include: a continuous memory containing all federally-designated airports and VORs in the continental U.S., 100 user programmable waypoints, automatic secondary selection, automatic magnetic variation adjustment, Two-leg flight planning with automatic sequencing, and an automatic brightness control for ambient light conditions. User entered memory is kept alive by an internal battery which has a nominal lifecycle of approximately 5 years.

Due to II Morrow's commitment to constantly improve the quality and performance of our equipment all specifications and features are subject to change without notice.

1.3 TECHNICAL SPECIFICATIONS

1.3.1 APOLLO II RECEIVER

1.3.1.1 ELECTRICAL CHARACTERISTICS

A. POWER

- 1) Operating Range
6.5 VDC to 48 VDC negative ground
15 Watts nominal
- 2) Maximum A-Line Power Consumption
1.09 A Nominal at 13.75 VDC
0.54 A Nominal at 28 VDC

B. INTERFACES

- 1) Course Deviation Indicator or Horizontal Situation Indicator with Autopilot Interface
 - a) Course Deviation Loads
1 to 5 1K ohm loads
 ± 150 uA full scale
 - b) Valid Flag Loads
1 1K ohm load
 ± 260 uA for flag out of view
- 2) External Annunciators (LORAN WARN, WAYPOINT ALERT, LORAN VFR, and APPROACH)
Max. 180 mA sink current each
Max. 30 VDC
- 3) RS-232 Serial Data Output Interface
Data is asynchronous, 1200 baud
Signal level is 0 to +5 Volts

3.1.2 PHYSICAL CHARACTERISTICS

- 1) Weight: 3.5 lbs (1.36 kg)
- 2) Size: Height - 3.25 inches (8.26 cm)
Width - 3.25 inches (8.26 cm)
Depth - 10.1 inches (25.65 cm)
(Depth is from front of front panel to rear of frame)
- 3) Mounting: Panel

3.1.3 OPERATIONAL CHARACTERISTICS

Operating Temperature - -20°C to +55°C (-4°F to 131°F)
Operating Humidity - 95% at +50°C (122°F)
Operating Altitude - 50,000 feet (15,240 m)
Track Speed - 600 knots at 0 dB SNR
Time to Track (GRI 9940)
 2 minutes at 0 dB SNR typical
 3½ minutes at -10 dB SNR typical
Update Rate of Current Position - 0.5 seconds nominal
Position Repeatability - 0.01 nm typical for primary LORAN-C areas
Range Resolution - 0.1 nm (600 feet)
Cross Track Distance Resolution - 0.01 nm (60 feet)
Cross Track Distance Display Resolution -
 Selectable: in 0.01 nm increments up to 1.00 nm

CDI Display - Enroute ±5.0 nm Full Scale
 Approach ±1.25 nm Full Scale

Memory - Continuous supplied by internal Lithium battery
 Nominal life approximately 5 years

Waypoints (In Lat/Long coordinates):
 FLYBRARY (All federally designated airports and VORs
 plus 100 user programmable identified by 4 alphanumeric
 characters), PPTO, and PPFR

Notch Filters - 8 Internal (Factory Preset)
Displays - High Intensity Alphanumeric Dot Matrix
Push Buttons - Backlighted

3.1.4 RECEIVER SPECIFICATIONS

Dynamic Range - 110 dB
Noise Bandwidth - 23 kHz at receiver output
Sensitivity - 1 uV nominal (atmospheric noise limited)
Minimum Signal-Noise-Ratio (SNR)
 Acquisition - -10 dB
 Track - -30 dB
 Position Display - -30 dB

1.3.2 LORAN-C ANTENNAS

1.3.2.1 A-16 WHIP ANTENNA with integral preamplifier (Standard)

- 1) Environmental Categories
Temperature and Altitude - - - - - D2
Humidity - - - - - A
Vibration - - - - - YJLM
Electromagnetic Compatability - - - - - Z
- 2) Physical Characteristics
Weight: 0.56 lbs (0.25 kg) Height: 17.75 in (45.09 cm)
- 3) Operational Characteristics
Operating Temperature - -55°C to +70°C
Operating Altitude - 50,000 feet (15,240 m)
Speed - 350 kts (402 mph) TAS

1.3.2.2 A-17 BLADE ANTENNA with integral preamplifier (Optional)

- 1) Environmental Categories
Temperature and Altitude - - - - - D2
Humidity - - - - - A
Vibration - - - - - YJLM
Electromagnetic Compatability - - - - - Z
- 2) Physical Characteristics
Weight: 0.70 lbs (0.32 kg) Height: 8.2 in (20.83 cm)
- 3) Operational Characteristics
Operating Temperature - -55°C to +70°C
Operating Altitude - 50,000 feet (15,240 m)
Speed - 521 kts (600 mph) TAS

1.3.2.3 A-23 BENT WHIP ANTENNA with integral preamplifier (Optional)

- 1) Environmental Categories
Temperature and Altitude - - - - - D2
Humidity - - - - - A
Vibration - - - - - YJLM
Salt Spray - - - - - S
Electromagnetic Compatability - - - - - Z
- 2) Physical Characteristics
Weight: 0.413 lbs (0.187 kg)
Size: Height - 8.25 inches (20.96 cm)
- 3) Operational Characteristics
Operating Temperature - -55°C to +70°C
Operating Altitude - 50,000 feet (15,240 m)
- 4) Speed - 350 kts (402 mph) TAS

Due to II Morrow's commitment to constantly improve the quality and performance of our equipment, all specifications and features are subject to change without notice.

1.3.2.4 A-6 PREAMPLIFIER (Optional)

- 1) Environmental Categories
 - Temperature and Altitude - - - - - A1, C2, D1
 - Humidity - - - - - A
 - Vibration - - - - - YJLM
 - Electromagnetic Compatability - - - - - Z
- 2) Physical Characteristics
 - Weight: 0.172 lbs (0.078 kg)
 - Size: Height - 0.75 inches (1.95 cm)
 - Width - 1.60 inches (4.06 cm)
 - Depth - 4.50 inches (11.4 cm)
- 3) Operational Characteristics
 - Operating Temperature - -55°C to +70°C
 - Operating Altitude - 50,000 feet (15,240 m)

Due to II Morrow's commitment to constantly improve the quality and performance of our equipment, all specifications and features are subject to change without notice.

1.3.4 RTCA ENVIRONMENTAL COMPLIANCE (TSO-C60a)

Model APOLLO II 612C

Part Number 430-0150-000

Designed to meet the following categories of DO-160B

CONDITIONS	SECTION/ PARAGRAPH #	DESCRIPTION OF CONDUCTED TESTS
TEMP AND ALTITUDE	4.0	TESTED TO CATEGORIES A1,D1 TESTED PER DO 159 para. 5.1
LOW TEMPERATURE	4.5.1	
HIGH TEMPERATURE	4.5.3	
ALTITUDE	4.6.1	
DECOMPRESSION	4.6.2	
OVERPRESSURE	4.6.3	
TEMPERATURE VARIATION	5.0	TESTED TO CATEGORY A TESTED PER DO 159 para. 5.2
HUMIDITY	6.0	TESTED TO CATEGORY A TESTED PER DO 159 para. 5.3
SHOCK	7.0	TESTED PER DO 159 para. 5.4 6g's 3 SHOCKS PER AXIS IMPULSE AND SUSTAINED SHOCK
OPERATIONAL	7.2	
CRASH SAFETY	7.3	
VIBRATION	8.0	TESTED TO CATEGORIES P,K,S PARA. 8.3.1 TESTED PER DO 159 para. 5.5
EXPLOSION	9.0	EQUIPMENT IDENTIFIED AS 'X' NO TEST REQUIRED
WATERPROOFNESS	10.0	EQUIPMENT IDENTIFIED AS 'X' NO TEST REQUIRED
FLUIDS SUSCEPTIBILITY	11.0	EQUIPMENT IDENTIFIED AS 'X' NO TEST REQUIRED

RTCA ENVIRONMENTAL COMPLIANCE (CONT)

Model APOLLO II 612C

Part Number 430-0150-000

SAND AND DUST	12.0	EQUIPMENT IDENTIFIED AS 'X' NO TEST REQUIRED
FUNGUS	13.0	EQUIPMENT IDENTIFIED AS 'X' NO TEST REQUIRED
SALT SPRAY	14.0	EQUIPMENT IDENTIFIED AS 'X' NO TEST REQUIRED
MAGNETIC EFFECT	15.0	TESTED TO CATEGORY Z TESTED PER DO 159 para. 5.12
POWER INPUT	16.0	TESTED TO CATEGORIES B,Z TESTED PER DO 159 para. 5.13
VOLTAGE SPIKE CONDUCTED	17.0	TESTED TO CATEGORY A TESTED PER DO 159 para. 5.14
AUDIO FREQUENCY CONDUCTED SUSCEPTIBILITY	18.0	TESTED TO CATEGORY Z TESTED PER DO 159 para. 5.15
INDUCED SIGNAL SUSCEPTIBILITY	19.0	TESTED TO CATEGORY Z TESTED PER DO 159 para. 5.16
RADIO FREQUENCY SUSCEPTIBILITY	20.0	TESTED TO CATEGORY Z TESTED PER DO 159 para. 5.17
RADIO FREQUENCY EMMISSION	21.0	TESTED TO CATEGORY Z TESTED PER DO 159 para 5.18
OTHER TESTS		

1.4 UNITS AND ACCESSORIES

1.4.1 Standard Units and Accessories Supplied

The APOLLO II package consists of the APOLLO II LORAN-C navigation receiver (Model 612C), installation kit, and the A-16 Whip antenna, optional A-17 High Speed Blade antenna (at extra cost), or optional A-23 Bent Whip antenna. The A-16 Whip antenna is the standard antenna to accompany the APOLLO II Model 612C.

1.4.1.1 Units Supplied

II Morrow P/N	Description	Quantity
430-0150-000	APOLLO II Model 612C	1
and		
430-0035-000	A-16 Whip Antenna	1

1.4.1.2 Accessories Supplied

INSTALLATION KIT

II Morrow P/N	Description	Quantity
162-1009	BNC Connector Taper Grip Cable	2
162-3006	15-pin D-Sub Hood	1
162-3019	15-pin D-Sub Socket	1
172-1501	Fuse - 5 Amp Fast Blow	1
221-0806	SCR PHP 8-32 x 3/8" SS	4
500-2008	Coaxial Cable 15 feet (RG58)	1
560-4011	612C Operation Manual Rev. 0, or later approved revision	1
560-4012	612C VFR Installation Manual	1
560-9002	Binder 8-1/2" x 5-1/2" 3-Ring	1
561-0025B	LORAN-C Aviation Warranty Card	1
565-1008	VFR Decal Placards	1

1.4.2 ACCESSORIES

Antennas other than the ones supplied with an APOLLO LORAN-C receiver package may be purchased as an option by arrangement with the retailer or the factory. External annunciator packages are available from the factory or retailer. Adapters for interfacing with a variety of CDIs and autopilots are available as options. A CDI that includes the external annunciators is also available.

1.4.2.1 ANNUNCIATORS

Appropriate Low Level Annunciator Lights (4) may be used for the external LORAN VFR, APPROACH, WAYPOINT ALERT and LORAN WARN Annunciators (see Figures 18, 19, & 20). The current draw for each external annunciator must not exceed 180 mA.

External annunciator panels are available from II Morrow Inc. in three physical configurations that provide annunciations of APPROACH, VFR WARN, WAYPOINT ALERT and LORAN WARN. See Figures 18, 19, and 20.

II Morrow P/N	Description
145-2100	LORAN Annunciator 2x2
145-2101	LORAN Annunciator 1x4 (Horizontal)
145-2102	LORAN Annunciator 4x1 (Vertical)

The LORAN annunciators available from II Morrow Inc. use two parallel lamps per annunciator. Use a T 1-3/4 bulb, midget flanged base lamp #387 (supplied) for 28 V installations or a #382 for 14 V installations.

1.4.2.2 ANTENNAS and PREAMPLIFIERS

Antennas optimized for use with APOLLO LORAN-C receivers are available from II Morrow Inc. For recommendations about special applications you should contact the factory.

430-0035-000	A-16 Whip Antenna with integral preamplifier
430-0038-000 or 430-0038-001	A-17 High Speed Blade Antenna with integral preamplifier
430-0066-000	A-23 Bent Whip Antenna with integral preamplifier

1.4.2.3 FC-02 LOW LEVEL FLAG ADAPTER

The FC-02 Low Level Flag Adapter is used to interface the APOLLO II with CDIs having separate movements for the TO/FROM flags and the NAV Flag.

430-0131-000 FC-02 Low Level Flag Adapter

1.4.2.4 FC-01 SUPERFLAG ADAPTER

The FC-01 Superflag Adapter is used to interface the APOLLO II with CDIs having separate movements for the TO/FROM flags and the NAV Flag or where a superflag input is required for an autopilot.

430-0125-000 FC-01 Superflag Adapter

1.4.2.5 MD-40 and MD-40L LORAN CDI

Two models of Course Deviation Indicators are provided which have been specially designed for use with LORAN-C navigation systems: the MD-40 and the MD-40L. The MD-40L has the provision for a lighted face while the MD-40 does not. Both CDIs have internal annunciators for LORAN WARN (WARN), LORAN VFR (VFR), WAYPOINT ALERT (WPT), and APPROACH (APR). The FC-01 or FC-02 are not needed when the MD-40 or MD-40L are used.

428-2000 MD-40 Course Deviation Indicator
428-2000L MD-40L Course Deviation Indicator

1.5 FAA APPROVAL OF AREA NAVIGATION INSTALLATION

For compliance with certified installation of the APOLLO II Model 612C, all guidelines within AC-43.13 Ch. 11, and this installation manual must be followed.

For compliance with certified installation of the the APOLLO II Model 612C, the appropriate placard (LORAN-C) must be displayed near the receiver unless otherwise specified. The additional placards provided are to be used for labeling a CDI, if connected, and for the indicators. The decal that MUST be used is: "LORAN SYSTEM TO BE USED FOR VFR ONLY".

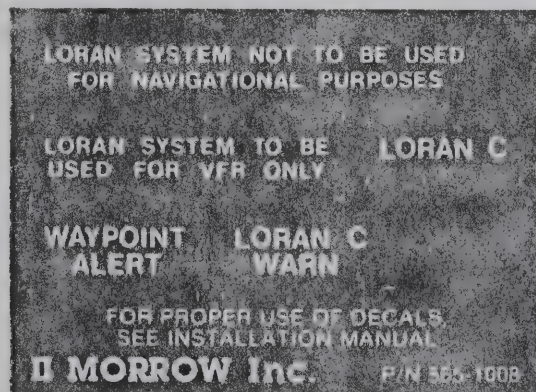


Figure I-2

1.6 EQUIPMENT LIMITATIONS

1.6.1 APOLLO II LORAN-C Receiver

The APOLLO II receiver is limited to operating on all LORAN-C chains existing as of January 1986. In order for the APOLLO II to operate on chains and secondaries other than those specified in the table below, a software revision will be required.

TABLE OF LORAN-C CHAINS

GRI	NAME	SECONDARY DESIGNATOR	CODING DELAY
4990	CENTRAL PACIFIC	XRAY YANKEE	11,000 29,000
5930	CANADIAN EAST COAST	XRAY YANKEE ZULU	11,000 25,000 38,000
5970	COMMANDO LION (KOREA)	WHISKY XRAY ZULU	11,000 31,000 42,000
5990	CANADIAN WEST COAST	XRAY YANKEE ZULU	11,000 27,000 41,000
7170	SAUDI ARABIA (SOUTH)	WHISKY XRAY YANKEE ZULU	11,000 26,000 39,000 52,000
7930	LABRADOR SEA	WHISKY XRAY	11,000 26,000
7960	GULF OF ALASKA	XRAY YANKEE	11,000 26,000
7970	NORWEGIAN SEA	XRAY WHISKY YANKEE ZULU	11,000 26,000 46,000 60,000
7980	SOUTHEAST U.S.	WHISKY XRAY YANKEE ZULU	11,000 22,000 43,000 59,000

TABLE OF LORAN-C CHAINS (cont.)

GRI	NAME	SECONDARY DESIGNATOR	CODING DELAY
7990	MEDITERRANEAN	XRAY YANKEE ZULU	11,000 29,000 47,000
8940	WESTERN EUROPE (FRANCE)	WHISKY XRAY	12,000 30,000
8970	GREAT LAKES	WHISKY XRAY YANKEE	11,000 28,000 44,000
9940	WEST COAST	WHISKY XRAY YANKEE	11,000 27,000 40,000
9960	NORTHEAST U.S.	WHISKY XRAY YANKEE ZULU	11,000 25,000 39,000 54,000
9970	NORTHWEST PACIFIC	WHISKY XRAY YANKEE ZULU	11,000 30,000 55,000 75,000
9980	ICELANDIC	WHISKY XRAY	11,000 30,000
9990	NORTH PACIFIC	XRAY WHISKY ZULU	11,000 29,000 43,000

1.6.2 Acquisition

The APOLLO II will acquire and track the Master and all available Secondaries of a specified chain and operate as specified.

1.6.3 Maximum Track Velocity

The maximum track velocity is 600 knots at 0 dB SNR.

1.6.4 VFR Restriction

The APOLLO II Model 612C is presently restricted to VFR use only.

1.7 RS-232 SERIAL DATA OUTPUT SPECIFICATIONS

The APOLLO II provides RS-232 serial data output for use in interfacing with computers possessing RS-232 data input capabilities. Data supplied will provide information on signal quality, position, and other displayed receiver functions. The specifications for the APOLLO Serial Data Output are described below.

Electrical Format:

RS-232C
Logic 1 = 0 Volts
Logic 0 = +5 Volts

Data Format:

Asynchronous, 1200 Baud
1 Start Bit
7 Data Bits
1 Parity Bit - Odd
1 Stop Bit

This data format conforms to Standard UART Data Format (INTEL 8251 and MOTOROLA MC6850).

The data is formatted into various groups representing receiver functions (i.e. Lat/Lon, SNR, and Signal Tracking status). Each data group is formatted by a control character followed by the data. Data is generally transmitted in ASCII format. A description of the data groups and their specifications is given below.

LATITUDE/LONGITUDE DATA GROUP

Character	Definition	Value
1	Start Character	'#'
2	Lat/Long Char.	'L'
3	Space	20H
4	Hemisphere	'N'
5	Lat. Deg. MSD	3_
6	Lat. Deg. LSD	3_
7	Lat. Min. MSD	3_
8	Lat. Min.	3_
9	Lat. Min.	3_
10	Lat. Min. LSD	3_
11	Space	20H
12	Hemisphere	'W'
13	Lon. Deg. MSD	3_
14	Lon. Deg.	3_
15	Lon. Deg. LSD	3_
16	Lon. Min. MSD	3_
17	Lon. Min.	3_
18	Lon. Min.	3_
19	Lon. Min. LSD	3_
20	<CR>	0DH

SNR VALUES DATA GROUP

Character	Definition	Value
1	Start Character	'#'
2	SNR Character	'S'
3	Space	20H
4	Master Identifier	'M'
5	Master SNR MSD	3 ₋
6	Master SNR	3 ₋
7	Master SNR LSD	3 ₋
8	Space	20H
9	Slave Identifier	'A'
10	Slave SNR MSD	3 ₋
11	Slave SNR	3 ₋
12	Slave SNR LSD	3 ₋
13	Space	20H
14	Slave Identifier	'B'
15	Slave SNR MSD	3 ₋
16	Slave SNR	3 ₋
17	Slave SNR LSD	3 ₋
18	<CR>	0DH

NOTE: After the APOLLO II has settled, the 'A' and 'B' slave identifiers will be replaced by the appropriate letter for the station selected in the current triad (W, X, Y, or Z).

TRIAD SELECTION STATUS DATA GROUP

The bits denoting the stations (M,W,X,Y,Z) are set according to the tracking status of the selected triad. If the MWX triad is used, then only the M,W,X status bits are defined. A "0" bit value implies tracking status. A "1" bit value implies non-tracking status.

Character	Definition	Value
1	Start Character	'#'
2	Status Character	'C'
3	Space	20H
4	Status Word	(D7: 0 (D6: 0 (D5: 0 (D4: M (D3: W (D2: X (D1: Y (D0: Z
5	<CR>	0DH

NAVIGATION MODE VALUES DATA GROUP (A)

Character	Definition	Value
1	Start Character	'#'
2	Identifying Character	'N'
3	Identifying Character	'A'
4	Space	20H
5	Bearing Identifier	'B'
6	Bearing MSD	3_
7	Bearing	3_
8	Bearing LSD	3_
9	Space	20H
10	Range Identifier	'R'
11	Range MSD	3_
12	Range	3_
13	Range	3_
14	Range	3_
15	Decimal Point	'.'
16	Range LSD	3_
17	Space	20H
18	Bearing (FROM) Identifier	'B'
19	Bearing (FROM) Identifier	'F'
20	Bearing (FROM) MSD	3_
21	Bearing (FROM)	3_
22	Bearing (FROM) LSD	3_
23	Space	20H
24	Range (FROM) Identifier	'R'
25	Range (FROM) Identifier	'F'
26	Range (FROM) MSD	3_
27	Range (FROM)	3_
28	Range (FROM)	3_
29	Range (FROM)	3_
30	Decimal Point	'.'
31	Range (FROM) LSD	3_
32	<CR>	0DH

NAVIGATION MODE VALUES DATA GROUP (B)

Character	Definition	Value
1	Start Character	'#'
2	Identifying Character	'N'
3	Identifying Character	'B'
4	Space	20H
5	DTK Identifier	'C'
6	DTK MSD	3_
7	DTK	3_
8	DTK LSD	3_
9	Space	20H
10	Distance Identifier	'D'
11	Distance MSD	3_
12	Distance	3_
13	Distance	3_
14	Distance	3_
15	Decimal Point	'.'
16	Distance	3_
17	<CR>	0DH

NAVIGATION MODE VALUES DATA GROUP (C)

Character	Definition	Value
1	Start Character	'#'
2	Identifying Character	'N'
3	Identifying Character	'C'
4	Space	20H
5	TRK Identifier	'T'
6	TRK MSD	3_
7	TRK	3_
8	TRK LSD	3_
9	Space	20H
10	GS Identifier	'S'
11	GS MSD	3_
12	GS	3_
13	GS	3_
14	Decimal Point	'.'
15	GS LSD	3_
16	Space	20H
17	ETE Identifier	'E'
18	ETE Identifier	'T'
19	ETE MSD	3_
20	Colon	':'
21	ETE	3_
22	ETE LSD	3_
23	Space	20H
24	XTD Identifier	'X'
25	XTD Identifier	'T'
26	XTD Sign	'+' or '-'
27	XTD MSD	3_
28	XTD	3_
29	Decimal Point	'.'
30	XTD	3_
31	XTD LSD	3_
32	<CR>	0DH

NOTE: When Ground Speed is less than 1.0 knot, the TRK and ETE digits will be replaced by dashes ('-') and the Ground Speed digits will be all zeros.

SECTION II
INSTALLATION PROCEDURES

2.1 GENERAL INFORMATION

This section presents installation and wiring information for the APOLLO II LORAN-C Navigation Receiver and antenna system.

2.1.1 Standard Practices

At all times, installation procedures should follow good aviation installation practices as per AC 43.13 Ch. 11 and this manual.

2.1.2 Installation Limitations

- 1) The antenna placement is possible on both the top or bottom of the aircraft. Preferred placement for best performance is top mounting. If bottom mounted, see sec. 2.3.2
- 2) The LORAN-C antenna must be at least 6 inches from a transmitting antenna that emits 25 W or less, and at least 2 feet away from a high power radio transmitting antenna.
- 3) The antenna must be of a type approved by II Morrow Inc. The list below indicates the currently approved antennas for use with the APOLLO II Model 612C:

Whip:	A-16	P/N 430-0035-000	(Standard)
Bent Whip:	A-23	P/N 430-0066-000	(Optional)
Blade:	A-17	P/N 430-0038-000 or 430-0038-001	(Optional)

- 4) In selecting an antenna mounting site, consider locations that meet the following criteria: low electrical noise, unobstructed reception, proper grounding to the aircraft frame, and adequate metal surface area for a good ground plane (this may need to be added by the installer).
- 5) A CDI or HSI display unit connected to the APOLLO II Model 612C must be one that has been previously FAA approved. Units such as a Sperry IN385A, RD650A, IN480, King KI525A, Aeronetics 9137, Collins IND350A, II Morrow MD-40L, or equivalent may be used. Units with internal conversions may not be used. CDIs that have separate movements for the TO/FROM and the NAV VALID flags (such as the Collins IND350A) must use the II Morrow FC-02 Low Level Flag Adapter P/N 430-0131-000 or the II Morrow FC-01 Superflag Adapter P/N 430-0125-000.
- 6) Autopilots requiring a superflag input must use the II Morrow FC-01 Superflag Adapter P/N 430-0125-000.
- 7) Circuit breakers or fuses shall not exceed a maximum current rating of 5.0 Amperes. Fuses, when used, shall be of the slow-blow type. Circuit breakers, when used, shall be resettable. Circuit breakers should meet MIL STD MS-25244-5, MS-22073-5, or MS-26574 (such as Klixon MS-26754-5, OR 7274-2-5).
- 8) Switches should meet MIL-1-45208A. Relays should meet MIL-STD-202B. If a remote switching box is used, the RSU-21 from Clinton Avionics is the recommended unit.

2.1.3 Static Precautions

LORAN-C installations are sensitive to precipitation static. Precipitation static may cause interference, or even loss of the signal, in severe weather conditions (dust, ice, rain, or snow). Engine exhaust may also cause precipitation static.

Special attention is required to protect the aircraft from precipitation static when navigation in inclement weather is expected.

The fuselage of the aircraft should have ground bonding straps between all sections and control surfaces to provide a common ground throughout the aircraft. All equipment should be well grounded to the aircraft frame. De-icing boots and doors should be bonded to the airframe. When making ground connections, use fine sandpaper to remove all paint and protective coatings. Use appropriate compounds for surface preparation and finishing of grounding points. Locate the antenna as far to the rear as possible on the aircraft.

Install static discharge wicks in the appropriate locations and according to the manufacturer's specifications. Be careful to insure that the wicks are well bonded and have them periodically inspected for damage. Use a good quality static discharge wick. Frayed tip wicks are not recommended.

The windshield of an aircraft often provides an additional source of electrical interference caused by frictional charging. Bonding the windshield to the airframe will reduce this source of interference.

2.2 UNPACKING AND INSPECTING EQUIPMENT

Exercise care when unpacking the equipment. Visually inspect the unit for any evidence of damage incurred during shipment. It is advised to retain the shipping container and packaging material in case reshipment becomes necessary.

NOTE: If a claim of damage needs to be filed, save the shipping container to substantiate the claim. The claim should be appropriately filed with the shipping company.

2.3 EQUIPMENT INSTALLATION

This section will detail the installation of the antenna, receiver, preamplifier, indicators, and wiring hookups. Read the entire section before beginning the installation process. Perform the system checkout procedure before sealing the work area in case problems occur. Additional information is provided on bottom mounting an antenna, air cooling, and helicopter installation.

2.3.1 Antenna Installation

II Morrow offers several antenna configurations for use with APOLLO II units. Antennas produced by II Morrow Inc. are optimized for use with the APOLLO LORAN-C receivers.

Antennas for the APOLLO II may either be top or bottom mounted. Top mounting is the recommended position, however if bottom mounting is required instructions are provided for the necessary internal adjustments in the APOLLO II (see section 2.3.2).

Proper grounding is one of the most important factors in LORAN-C antenna installation. Optimum grounding and antenna performance may be obtained with direct metal-to-metal contact between the antenna base and aircraft skin (or installed ground plane). Paint should be removed beneath the antenna base and the surface should be lightly sanded. In some cases, a heavy gauge wire between the antenna base and the aircraft may be required.

Optimum antenna performance requires an adequate metal surface below the antenna mount to create a ground plane. If the selected antenna position does not provide a sufficient ground plane, the installer will need to create one by using a wire mesh, wire radials, or metal plating. The ground plane, installed or otherwise, must be connected to the aircraft chassis ground.

II Morrow Inc. LORAN-C antennas are vertically polarized with the preamplifier internally mounted. The antennas are connected directly to the APOLLO II. The connecting cable should be RG58A/U or RG58/U. The length is not critical (length should not exceed 100 ft).

The A-16 whip antenna is the standard antenna with the APOLLO II. The maximum recommended speed for the A-16 whip antenna is 350 knots (402 mph) TAS.

The A-17 blade antenna is an optional antenna with the APOLLO II. The maximum recommended speed for the A-17 blade antenna P/N 430-0038-000 is 521 knots (600 mph) TAS. The maximum recommended speed for the A-17 blade antenna P/N 430-0038-001 is 600 knots (690 mph or 0.9 mach) TAS.

The A-23 bent whip antenna is an optional antenna with the APOLLO II. The maximum recommended speed for the A-23 bent whip antenna is 350 knots (402 mph) TAS.

Never wax or paint an antenna. Coating an antenna with a foreign substance may severely reduce the received signal. Some paints may not be removed without destroying the P-Static coating of the antenna.

2.3.2 Bottom Mounted Antenna Placement

While the best location for antenna installation is on the top of the aircraft, it is possible to mount the antenna on the bottom. Phase reversal of the LORAN-C signal occurs when the antenna is bottom mounted. The APOLLO II has an internal jumper wire connection on the Digital Board to correct for this condition. The diagram below shows the position of the jumper connection (see Figure 3). The jumper should be in the "+" position for a top mounted antenna and should be in the "-" position for a bottom mounted antenna. The APOLLO II comes from the factory with the jumper in the "+" position.

The Digital Board is located beneath the bottom cover of the APOLLO II. Access is gained by removing the six phillips screws attaching the bottom cover, three on each side. The Digital Board is actually divided into two sections, outer and inner. Connector J7 is located on the inner Digital Board midway along the right edge as you are facing the front of the unit. The jumper for connector J7 may be reached by bending it out slightly or by removing the outer Digital Board. The outer Digital Board can be folded out of the way by removing the five phillips screws fastening the board to the chassis. The pins on connector J7 are numbered 1 - 6 from front to back. The jumper between pins 1 and 2 is for the "-" phase position. The jumper between pins 2 and 3 is for the "+" phase position.

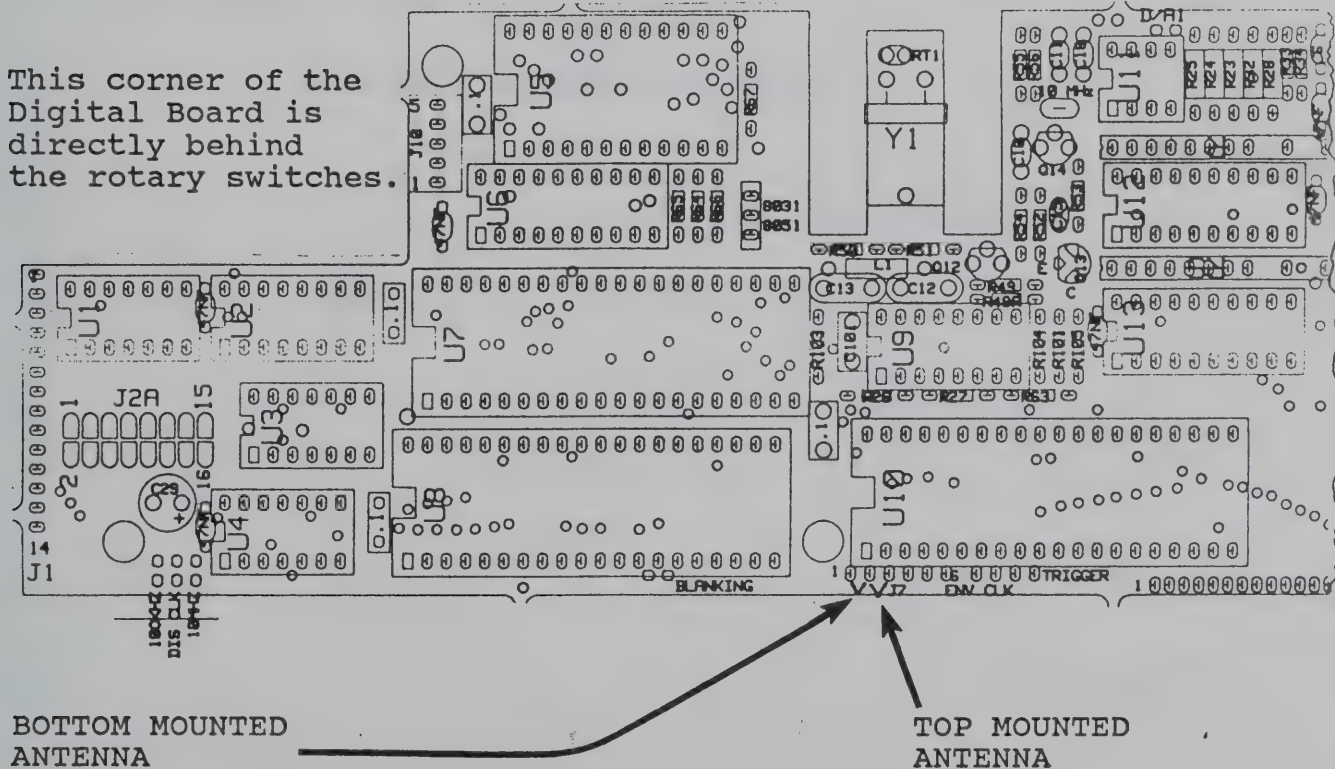


Figure 3

WHIP ANTENNA

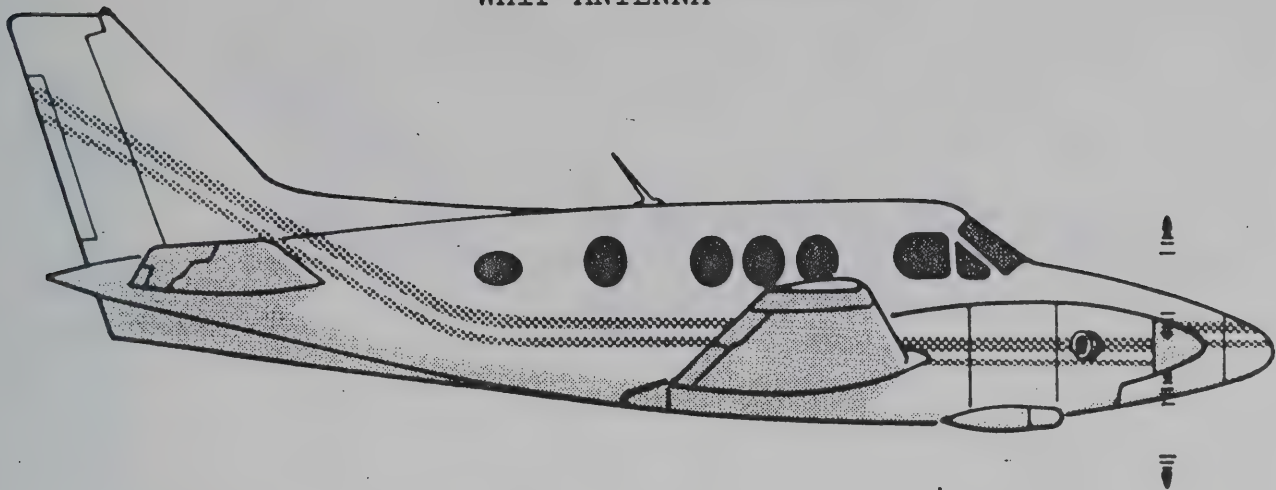
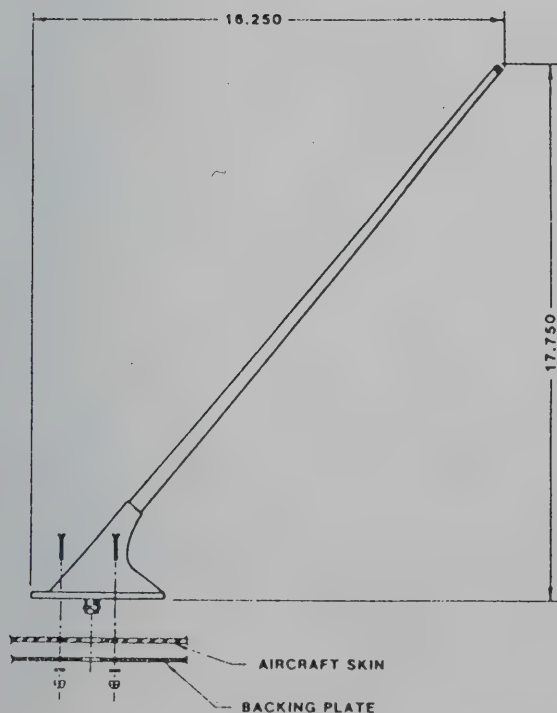


Figure 4

Locate the A-16 at least 6 inches away from a transmitting antenna that emits 25 W or less, and two feet away from a high power transmitting antenna. Do not use the A-6 preamplifier with the A-16 antenna.

NOTE: The antenna should be placed as high as possible for optimum performance.

A-16 WHIP ANTENNA and MOUNT



A-16 MOUNTING TEMPLATE

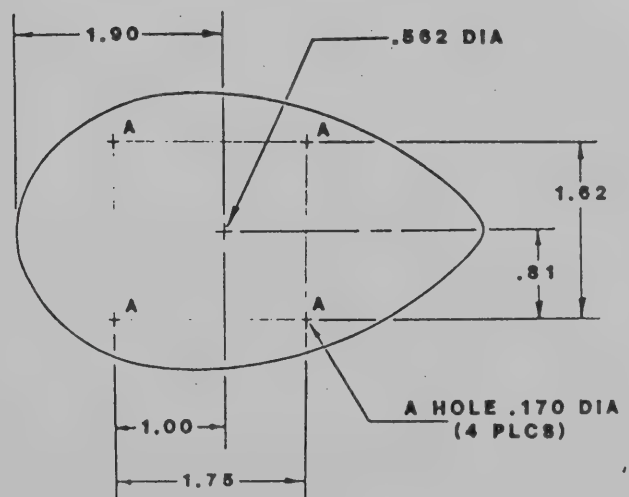


Figure 5

BENT WHIP ANTENNA

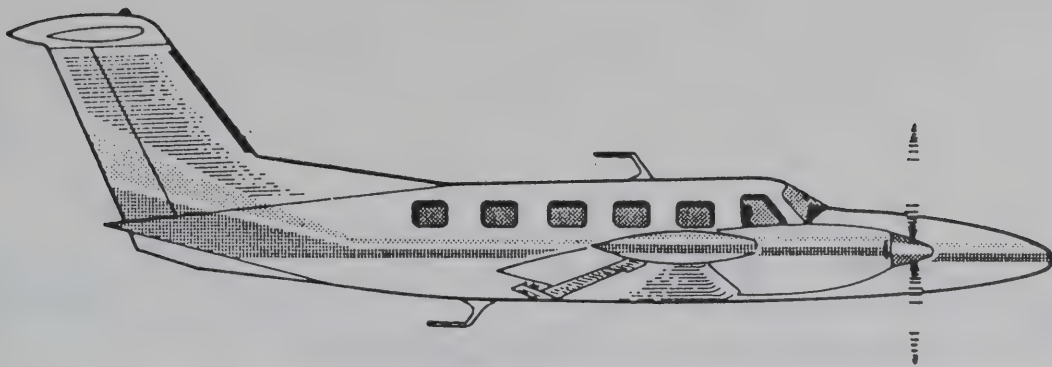


Figure 6

Locate the A-23 at least 6 inches away from a transmitting antenna that emits 25 W or less, and two feet away from a high power transmitting antenna. Do not use the A-6 preamplifier with the A-23 antenna.

NOTE: The antenna should be placed as high as possible for optimum performance.

A-23 WHIP ANTENNA and MOUNT

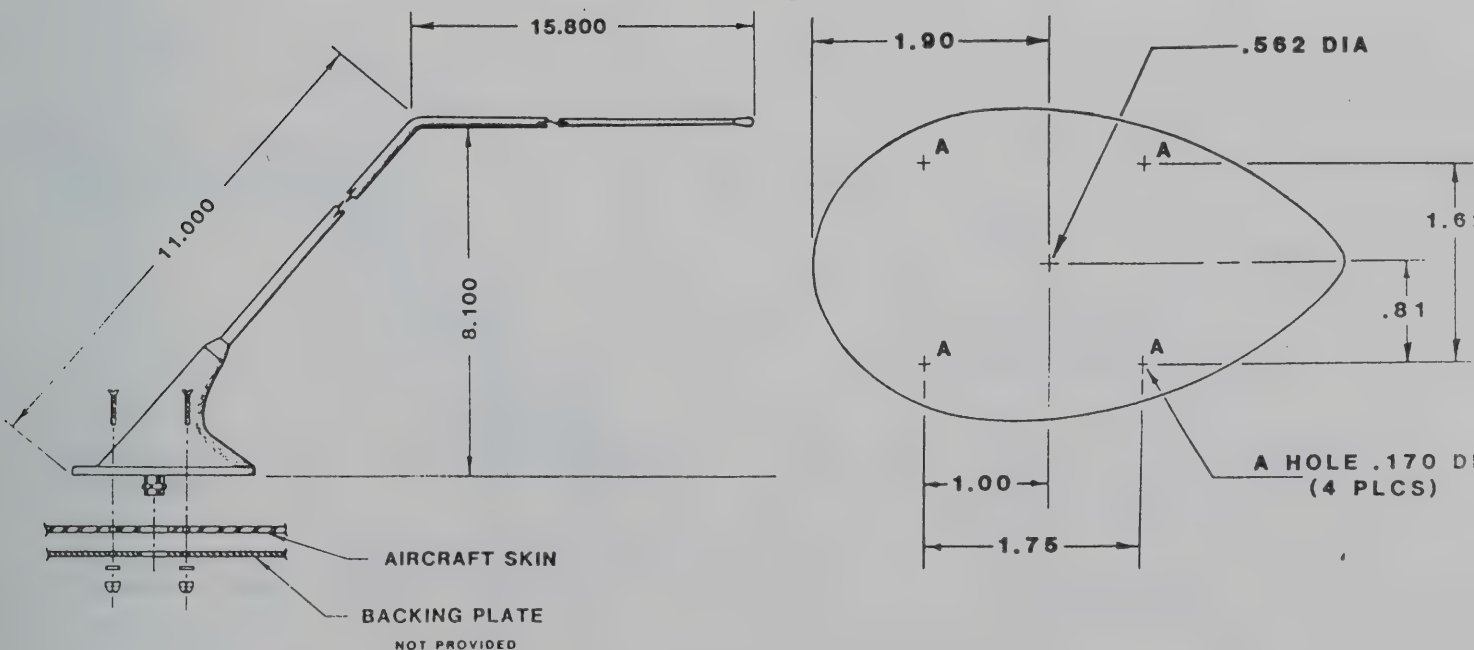


Figure 7

BLADE ANTENNA

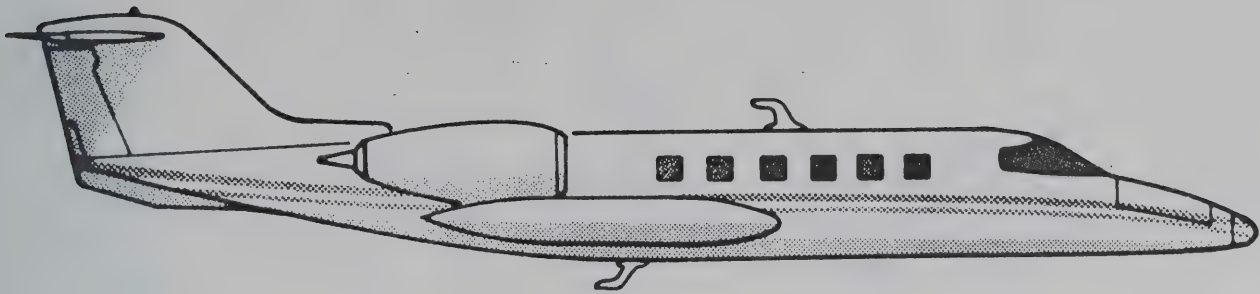


Figure 8

Locate the A-17 at least 6 inches away from a transmitting antenna that emits 25 W or less, and at least two feet away from a high power transmitting antenna. Do not use the A-6 preamplifier with the A-17 antenna. The supplied coax cable which connects between the APOLLO LORAN-C receiver and the antenna may be changed in length.

NOTE: The antenna should be placed as clear as possible from obstructions for optimum performance. Bottom mounting is permitted (see section 2.3.2).

A-17 BLADE ANTENNA and MOUNT

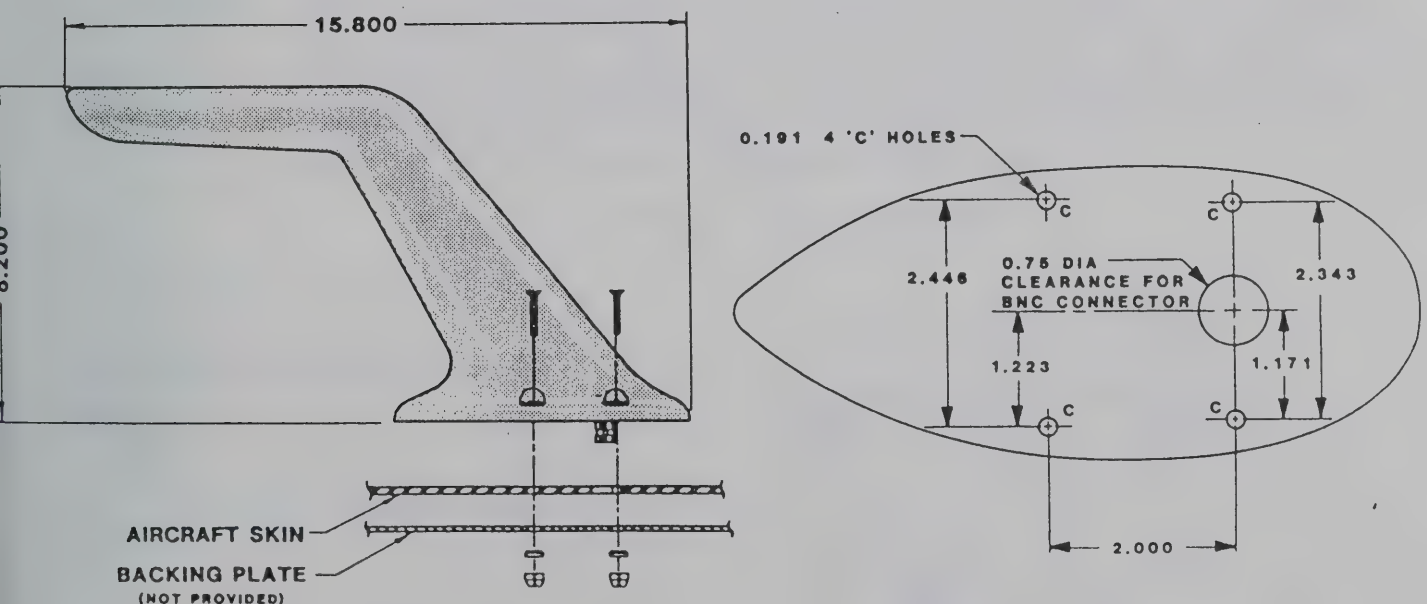


Figure 9

LONG WIRE ANTENNA

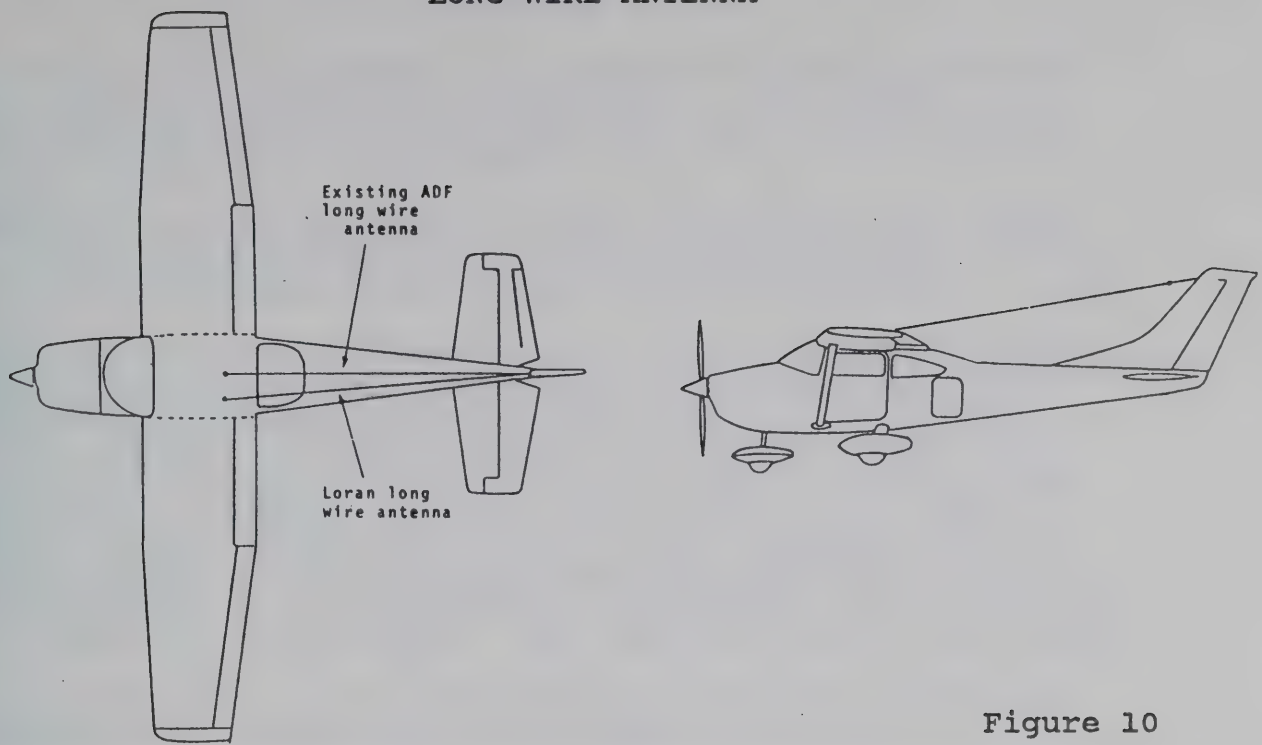


Figure 10

Use the Dayton-Granger 15620 long wire antenna or equivalent.

LORAN-C long wire antenna may be mounted next to the ADF long wire antenna. An existing ADF long wire antenna may be used as the LORAN-C long wire when the LORAN-C installation replaces an ADF system.

The long wire antenna should be four ft. or longer.

NOTE: The A-6 preamplifier is required when using a long wire or integral antenna. The supplied coax cable to connect between the preamplifier and the antenna is 6" long and MUST NOT be lengthened. The supplied coax cable which connects between the APOLLO LORAN-C receiver and the preamplifier may be changed in length.

A-6 LORAN-C PREAMPLIFIER

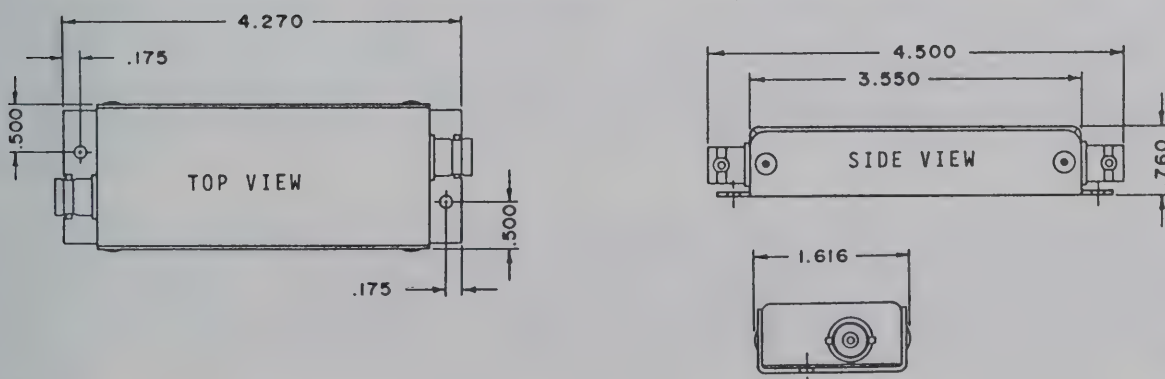


Figure 11

2.3.3 APOLLO II Receiver Installation

The APOLLO II LORAN-C Receiver is designed to be panel mounted with the enclosed accessories and hardware. The APOLLO II is best located in a position where the pilot has a clear view of the display during instrument scans.

The APOLLO II is very sensitive and uses relatively low signal levels. The APOLLO II should not be located near motors, or any other item which creates high levels of electrical noise.

The installation procedure described is illustrated with several diagrams. The recommended installation procedure begins with the determination of required clearances for the receiver in the panel. Figure 21 combines a view of the front panel with dimensions and a view of the top and side views with dimensions. The depth of the receiver from the front panel to the rear connectors is 10.1 inches (25.65 cm). Allow adequate depth in the mounting area to prevent sharp bends in any cable or wire. Leave a clearance of 1/4" between all components of the avionics stack for cooling, if possible. See section 2.3.6 on air cooling.

A diagram (Figure 22) of the Installation Assembly illustrates the electrical and mechanical connections to the unit.

The APOLLO II Model 612C is held in the front panel two screws and the collar for the power actuator. Use a 1/16" hex allen wrench to remove the power actuator sleeve from the power actuator shaft and the two knobs from the rotary switch shaft. Unscrew the collar from the power actuator shaft.

Install the unit into the panel when the electrical connections are completed. Carefully insert the APOLLO II into the front panel from the rear. Screw the two screws through the instrument panel into the APOLLO II. Slide the collar over the power actuator shaft and screw it through the instrument panel into the the APOLLO II. Slide the power actuator sleeve over the shaft and fasten it with the 1/16" hex set screw. Slide the two concentric knobs over the rotary switch shaft and fasten the smaller knob with the 1/16" hex set screw.

2.3.4 Wiring Instructions

Determine the length and routing of all cables before actual installation. When installing cables, avoid any sharp bends or placement near the aircraft control, power, DME, transponder, or radio communications cables. Wire must meet MIL-W-22759 or MIL-W-5086. PVC insulated wire may be used, but Tefzel or Teflon insulated is preferred.

The wiring necessary for the installation of the APOLLO II includes the rear panel electrical connections and antenna/preamplifier cable placement. Preparation of the antenna and/or preamplifier cables is also necessary. The panel receptacle must be assembled and may be wired before or after being installed into the mounting frame.

A wiring diagram (Figure 23) shows the electrical connections. The recommended connecting wire size is 20 AWG. A pin assignment list is shown in Figure 29.

Measure the length of coax cable needed to connect the antenna (with integral preamplifier) to the receiver unit. 15 feet of coax cable (RG58U II Morrow P/N 500-2024) are provided. Begin to prepare the required length of coax cable as described by "Cable Preparation and Assembly" after determining necessary routing. Run the coax cable to the antenna preamplifier and secure the BNC connector.

2.3.4.1 Cable Preparation and Assembly for BNC Connector P/N 162-1009

- 1) Cut the cable end square. Remove jacket, braid, and cut dielectric $1/4"$. Cut cable jacket back only an additional $1/32"$. Be careful not to nick the braid. Flare the braid to accept the cone. Slit the jacket $1/4"$ in 2 places 180° apart. Tin the center conductor.

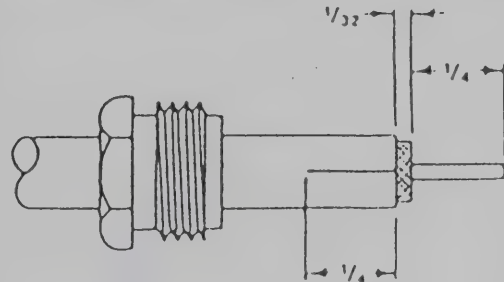


Figure 12

- 2) Slide the cone assembly under the braid until it touches the shoulder. Soft solder the contact to the center conductor.

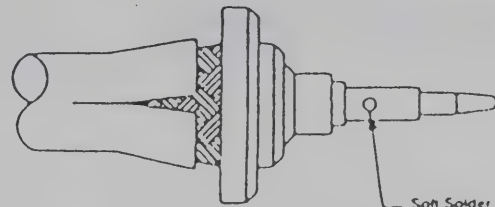
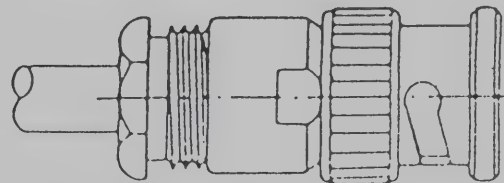


Figure 13

- 3) Slide the clamp nut over the flared portion of the cable. Thread the connector body onto the nut while holding the nut stationary. Tighten securely.



Attach to Preamplifier or Antenna

Figure 14

2.3.4.2 ANNUNCIATORS

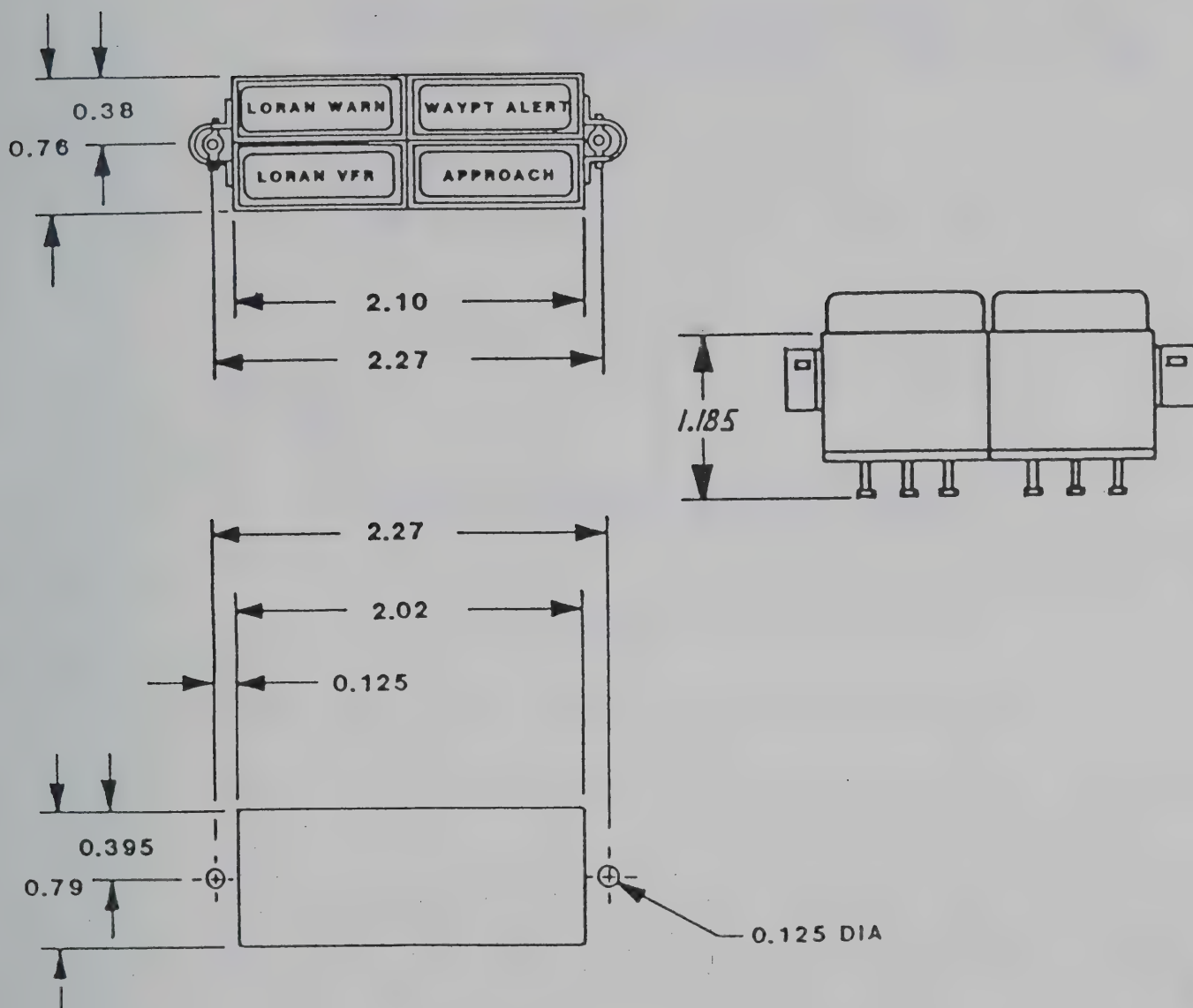
The external LORAN VFR, APPROACH, WAYPOINT ALERT and LORAN WARN annunciator connections are shown on the wiring diagram in Figure 23. The APOLLO II output operates as a grounding switch. Annunciators available from II Morrow, Inc. are shown in Figures 18, 19, and 20.

CAUTION: Do NOT apply 12 or 28 VDC directly to pins 1 and 3 of the back panel connector. If you choose not to connect the annunciators, leave the pins unconnected. The maximum sink current, or current that can be shorted to ground, is 180 mA for each annunciator or relay (see Figures 23 and 24).

Mount the external annunciators in a location that is in full view of the pilot. Use the measurements of Figures 18, 19, or 20 to drill the mounting holes and to cut the panel for annunciator placement.

LORAN-C EXTERNAL ANNUNCIATOR PANEL

II MORROW, INC. P/N 145-2100



ANNUNCIATOR MESSAGE	COLOR
LORAN WARN	RED
WAYPT ALERT	AMBER
LORAN VFR	AMBER
APPROACH	AMBER

Figure 18

LORAN-C EXTERNAL ANNUNCIATOR PANEL

II MORROW, INC. P/N 145-2101

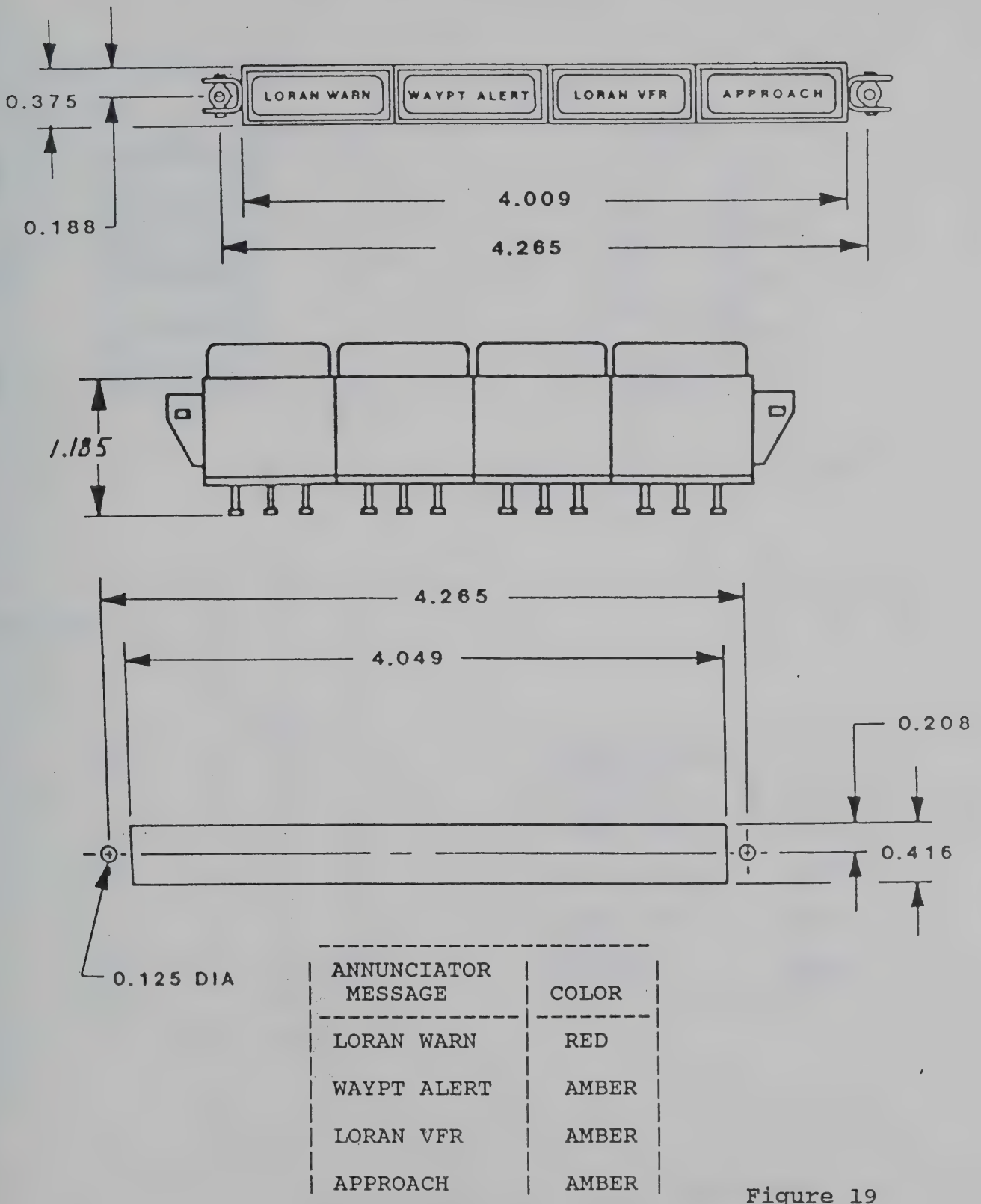
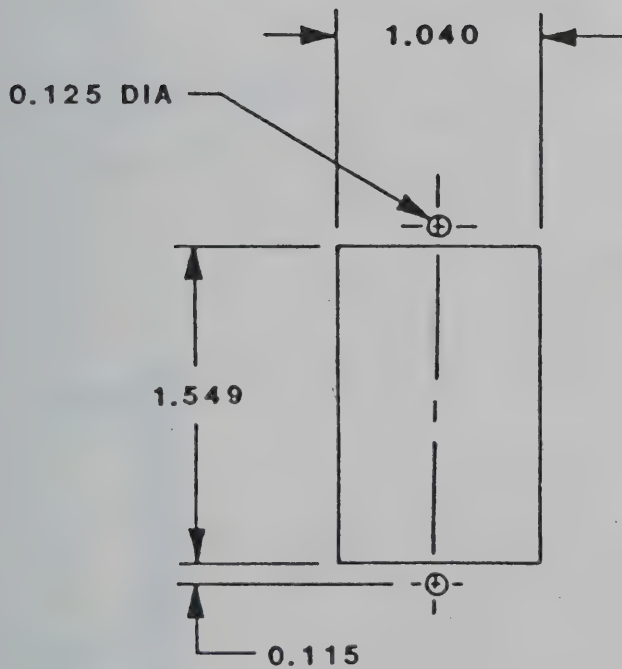
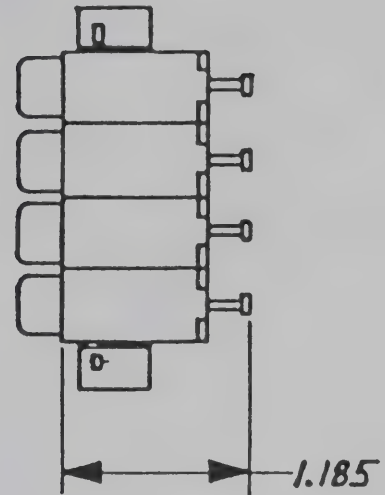
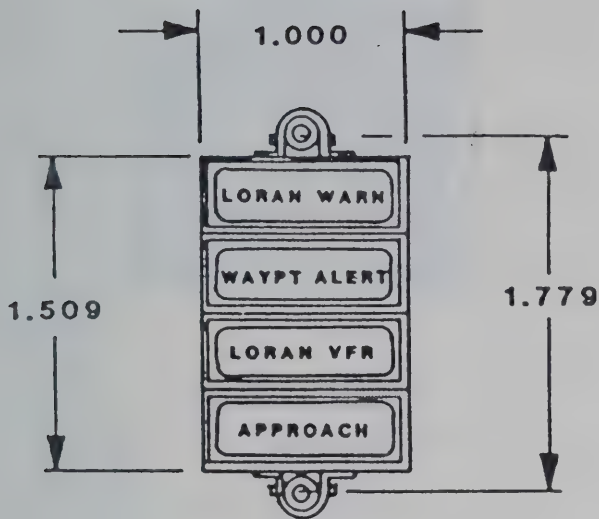


Figure 19

LORAN-C EXTERNAL ANNUNCIATOR PANEL

II MORROW, INC. P/N 145-2102

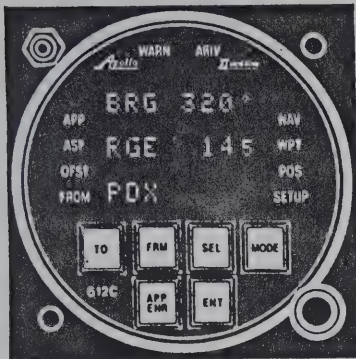


ANNUNCIATOR MESSAGE	COLOR
LORAN WARN	RED
WAYPT ALERT	AMBER
LORAN VFR	AMBER
APPROACH	AMBER

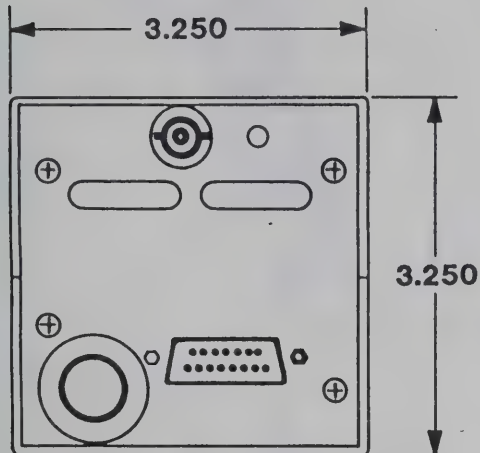
Figure 20

FRONT, BACK, AND SIDE VIEWS
FOR THE
APOLLO II MODEL 612C

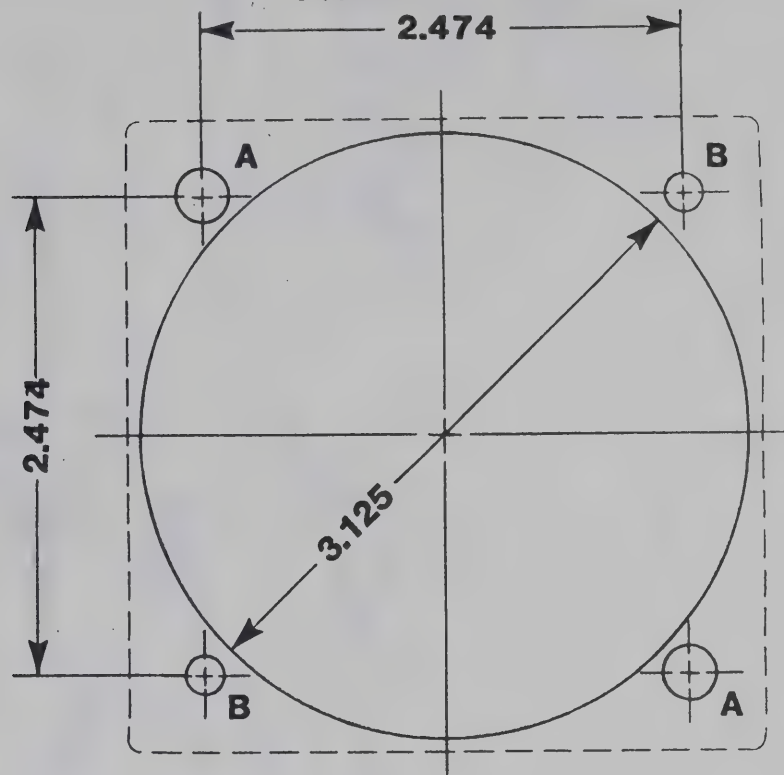
FRONT VIEW



REAR VIEW



PANEL CUTOUT



B. 13 DRILL(3/16)

A. H DRILL(17/64)

DRILL SIZES

SIDE VIEW

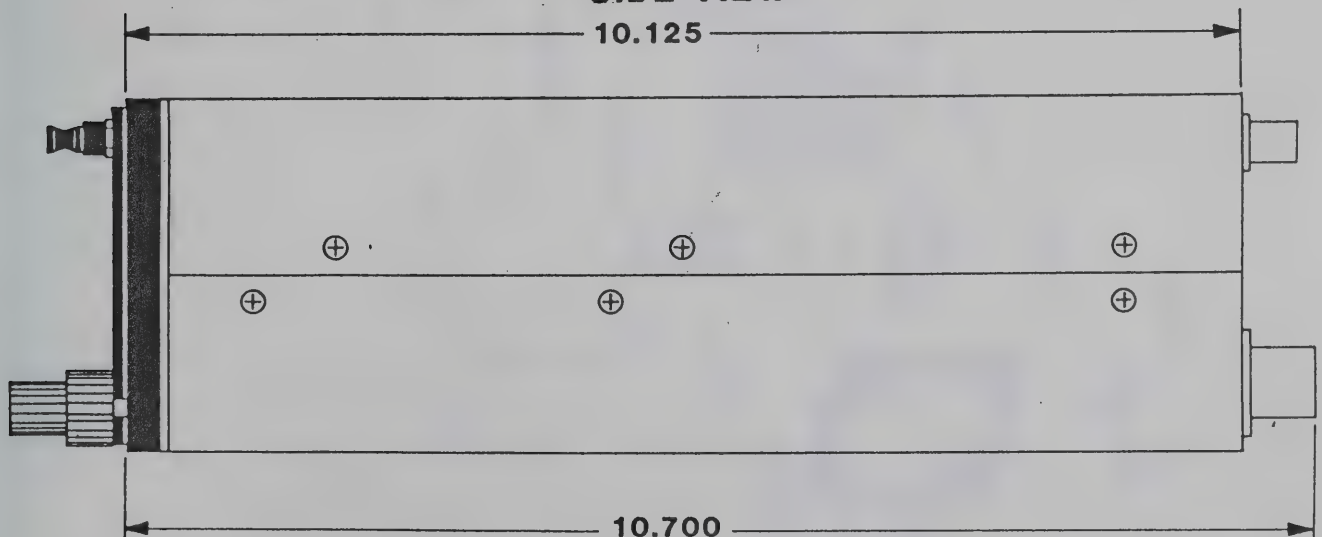
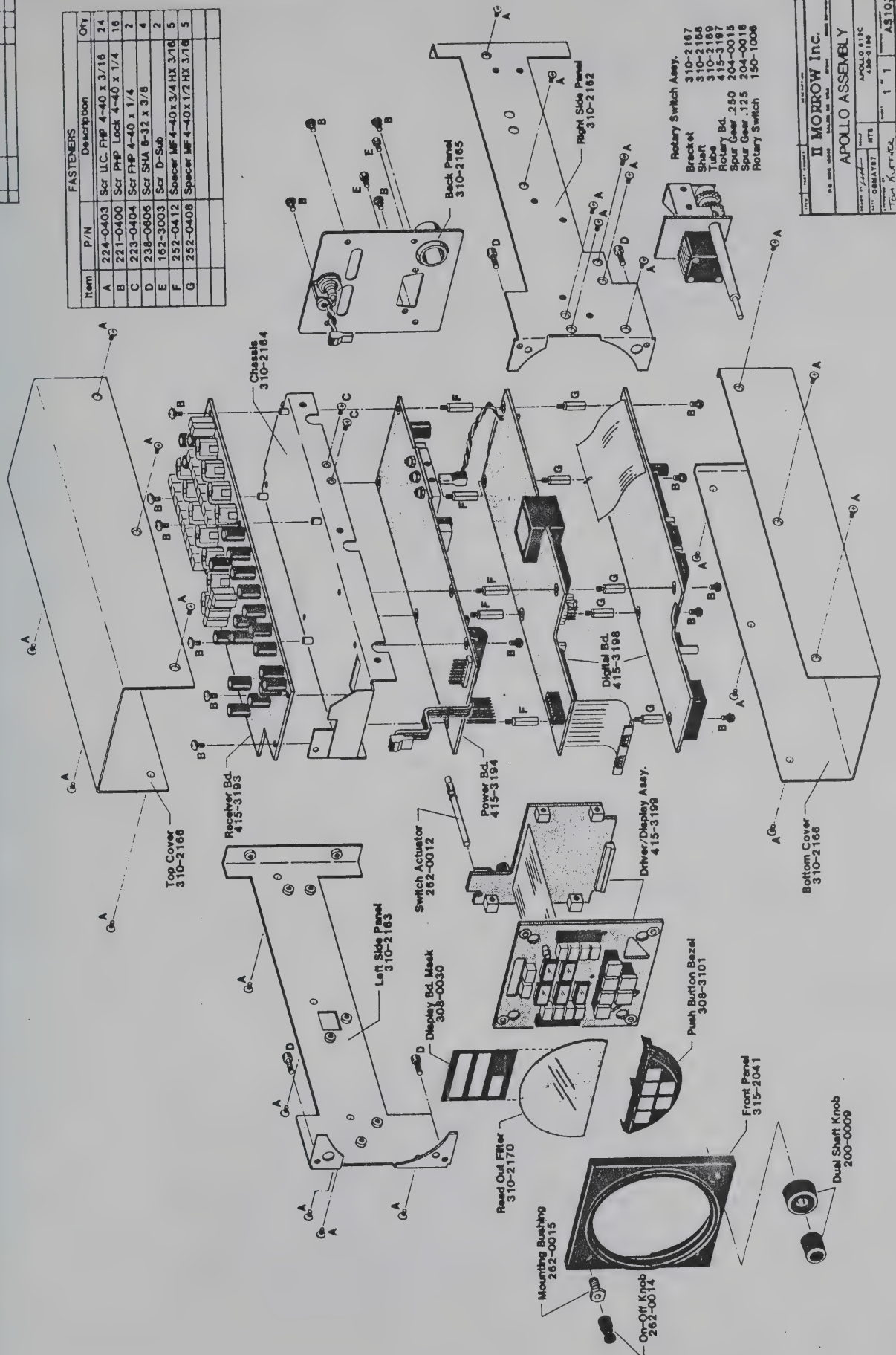


Figure 21

FASTENERS			Qty
Item	P/N	Description	
A	224-0403	Scr U.C. FHP 4-40 x 3/16	24
B	221-0400	Scr FHP Lock 4-40 x 1/4	16
C	223-0404	Scr FHP 4-40 x 1/4	2
D	238-0606	Scr SHA 6-32 x 3/8	4
E	162-3003	Scr D-Sub	2
F	252-0412	Spacer MF 4-40 x 3/4 HX 3/16	5
G	252-0408	Spacer MF 4-40 x 1/2 HX 3/16	5



II MORROW Inc.		Rev. 1	1	A51032
APOLLO ASSEMBLY				
Part No. 310-2166	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2167	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2168	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2169	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2170	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2171	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2172	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2173	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2174	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2175	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2176	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2177	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2178	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2179	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2180	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2181	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2182	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2183	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2184	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2185	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2186	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2187	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2188	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2189	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2190	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2191	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2192	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2193	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2194	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2195	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2196	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2197	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2198	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2199	Rev. 1	Rev. 1	Rev. 1	Rev. 1
Part No. 310-2200	Rev. 1	Rev. 1	Rev. 1	Rev. 1

INSTALLATION WIRING DIAGRAM FOR THE APOLLO II MODEL 612C

See Figures 18, 19, and 20
for external annunciator packages.

Optional Dimmer Circuit

Use a 1N2980 16V 10W
Zener Diode for 28V
installations or a
1N2970 6.8V 10W Zener
Diode for 14V
installations. Use a
heat sink with the zener.

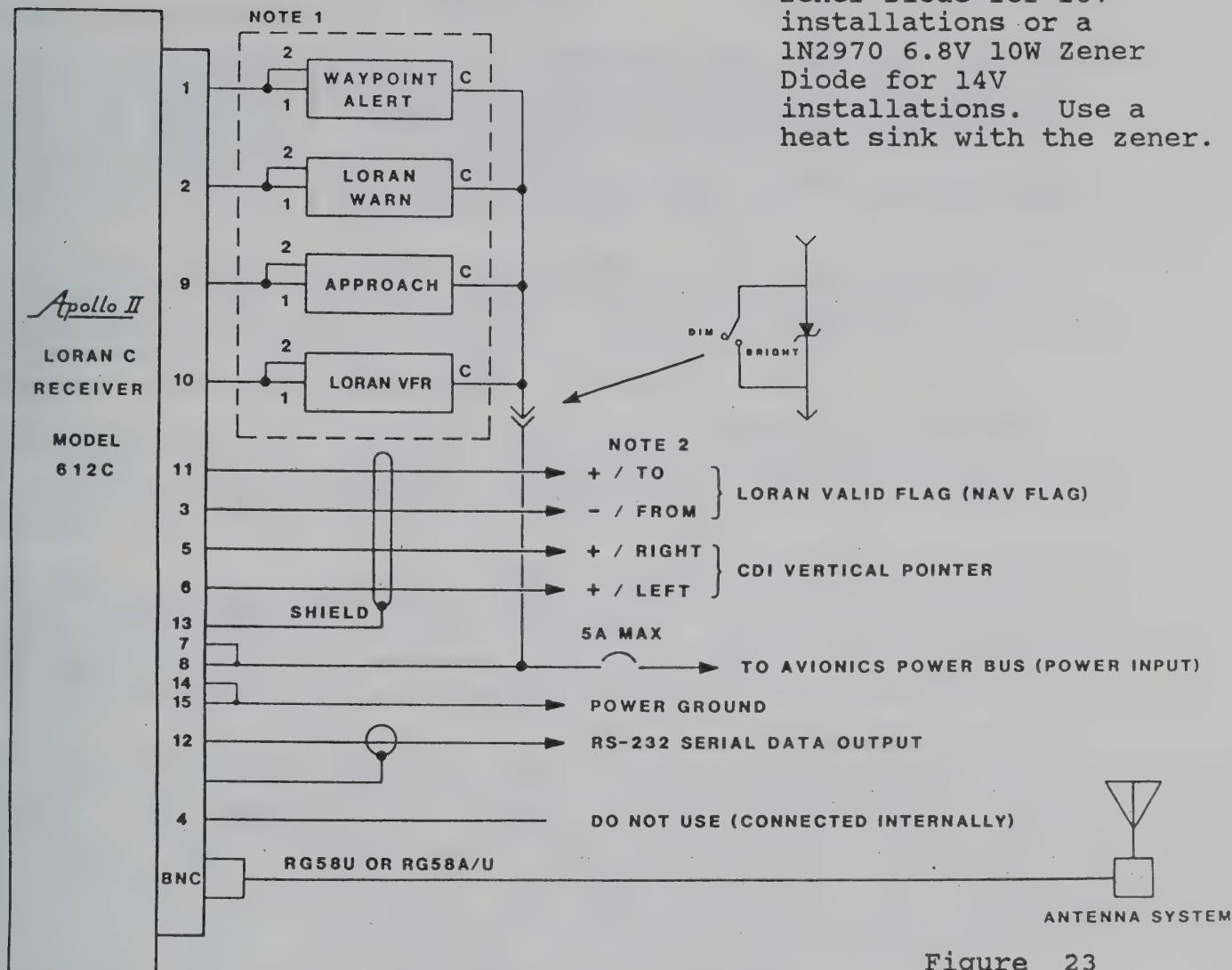


Figure 23

NOTE 1: Use 12 or 28 Volt indicator lamps or relays depending on the supply voltage. Lamps or relays MUST NOT draw more than 180 mA each. If a relay is used, a diode must be placed across the relay as shown. A relay meeting MIL-STD-202B is approved. An example is: Potter & Brumfield R 10-E1-V430 24VDC 6PDT (24 V application).

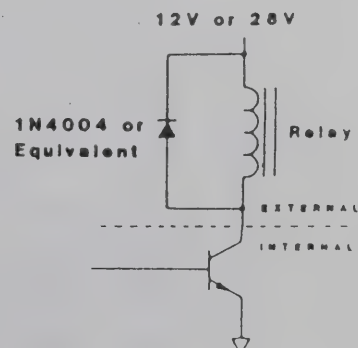


Figure 24

NOTE 2: Due to the diversity of CDI movements available the following notes on CDI/AUTOPILOT/HSI Interface may be used to guide the installer for the application necessary. CDIs that have separate TO/FROM and NAV VALID FLAG movements require the use of the FC-02 Low Level Flag Adapter or the FC-01 Superflag Adapter. The FC-01 Superflag Adapter is required when an autopilot is used that requires a superflag input.

2.3.4.3 CDI/AUTOPILOT/HSI INTERFACE

The APOLLO LORAN-C receiver will interface with low level (± 150 uA) CDI and HSI meters. The wiring diagram shown above indicates the pins to be connected. The APOLLO LORAN-C receiver CDI interface will not operate with units that have internal CDI or HSI conversions. CDIs with 200 ohm TO/FROM meter movements require a 750 ohm resistor (1/8 or 1/4W) in series with the TO/FROM movement.

HSI systems may be connected in parallel to the Left/Right connections (Pins 6 and 5). Autopilots may then be connected to the appropriate outputs of the HSI. Follow the Autopilot or HSI manufacturer's directions. Up to four 1 K ohm loads may be connected between the LEFT/RIGHT (6,5) pins.

The only proper flags that will appear for LORAN-C information are: "OFF", "FROM", and "TO". When using a CDI that has a 200 ohm/250 mV meter movement specification, the APOLLO LORAN-C receiver output will drive only one NAV flag.

CDIs with a single integral TO/FROM and OFF movement: Pin 11 (+TO) of the 15-pin connector should connect to the CDI "+TO" and Pin 3 (-FROM) should connect to the CDI "+FROM". The "TO" or "FROM" flag will appear whenever LORAN-C steering information is valid. Up to four 1 K ohm loads may be connected between the TO/FROM (11,3) pins.

CDIs with separate TO/FROM and NAV VALID FLAG movements require the use of the FC-02 Low Level Flag Adapter or FC-01 Superflag adapter. When using the FC-02, pin 11 (+TO) of the APOLLO 15-pin connector should connect to the CDI "+TO" and to the BLUE wire of the FC-02. Pin 3 (-FROM) should connect to the CDI "-FROM" and to the ORANGE wire of the FC-02. The YELLOW wire from the FC-02 should connect to the CDI "-NAV" and the GREEN wire should connect to the CDI "+NAV" input. See figures 25 and 26 for connection examples. Only one CDI NAV VALID flag may be driven in this configuration.

The FC-01 Superflag Adapter is used for interfacing to autopilots requiring a superflag input or for CDIs with separate TO/FROM and NAV VALID FLAG movements. When using the FC-01: connect pin 3 (-FROM) of the APOLLO 15-pin connector to pin 1 of the FC-01; pin 11 (+TO) to pin 6 of the FC-01, and pin 8 (Ground) of the APOLLO connector to the shield of the twisted wire pair used for this connection. Pin 5 of the FC-01 is connected to the fused avionics power bus and pin 4 is connected to the airframe ground. Pin 3 of the FC-01 is connected to the superflag input of the autopilot. Pin 8 of the FC-01 is connected to the NAV flag input and pin 9 is connected to the CDI ground and the shield of this twisted pair. The FROM, TO, LEFT, and RIGHT pins of the APOLLO connector should be connected to the appropriate pins of the autopilot and CDI.

LORAN/CDI INTERCONNECTION

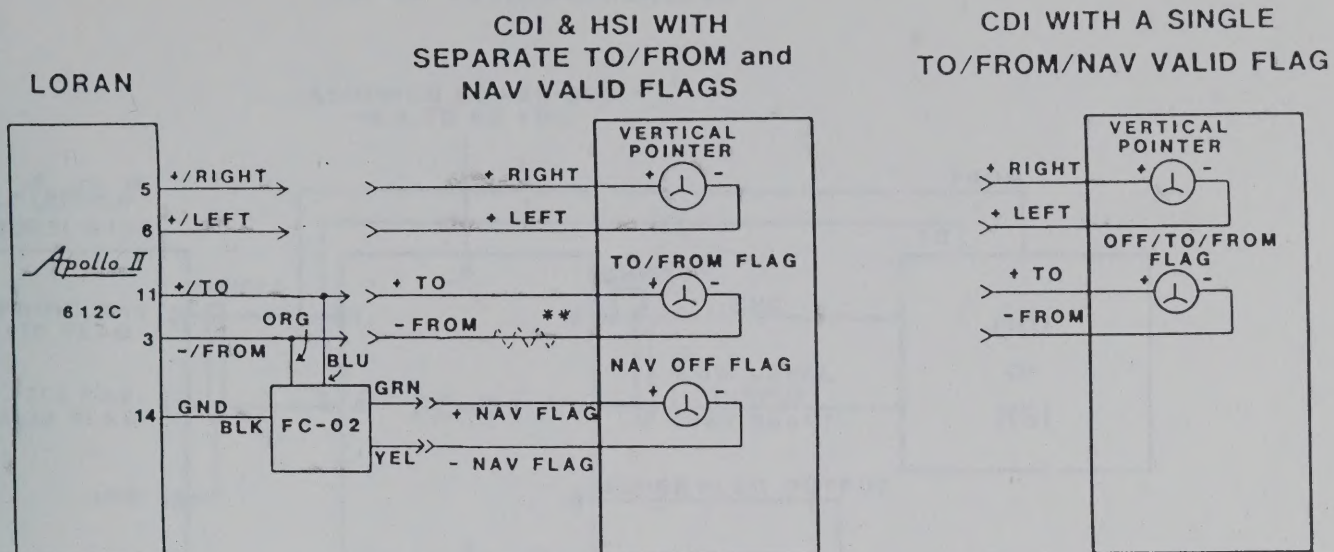


Figure 25

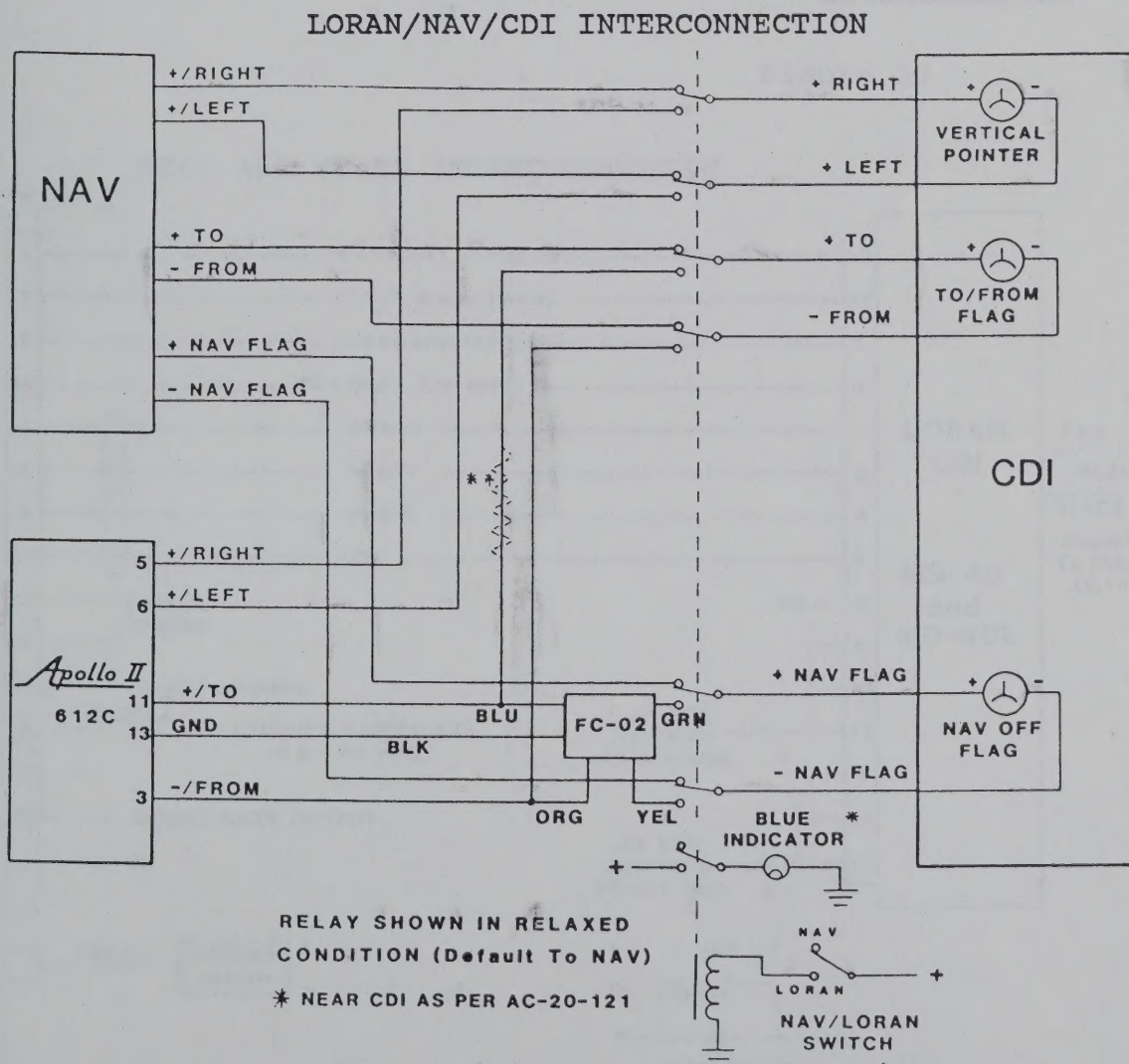


Figure 26

FC-01 INTERCONNECTION

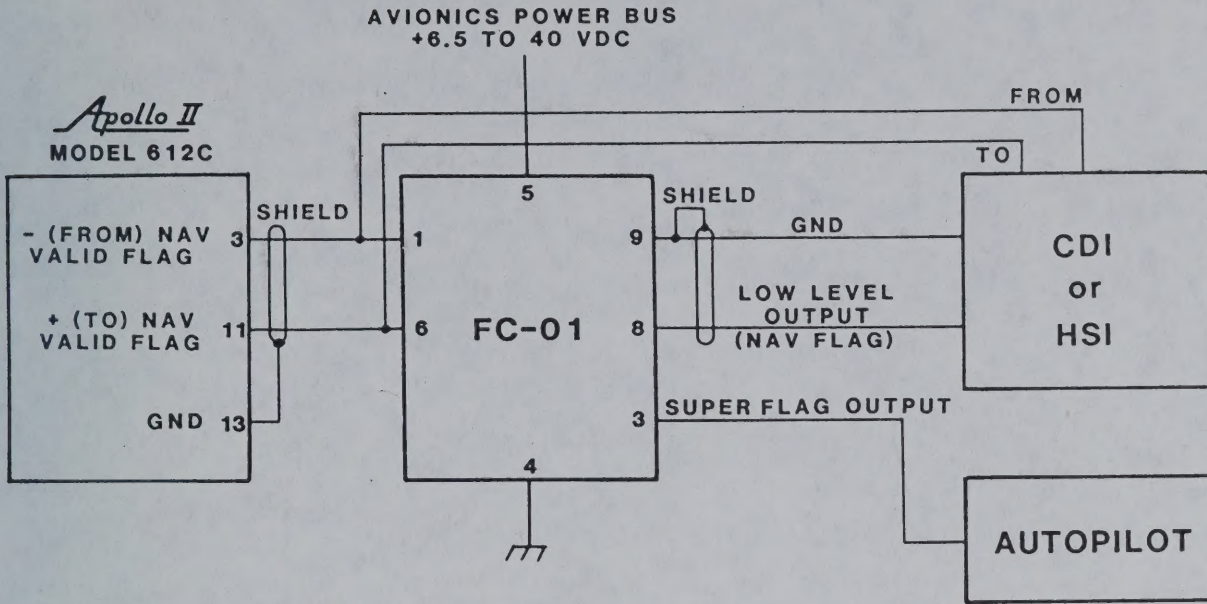


Figure 27

MD40 AND MD40L INTERCONNECTION

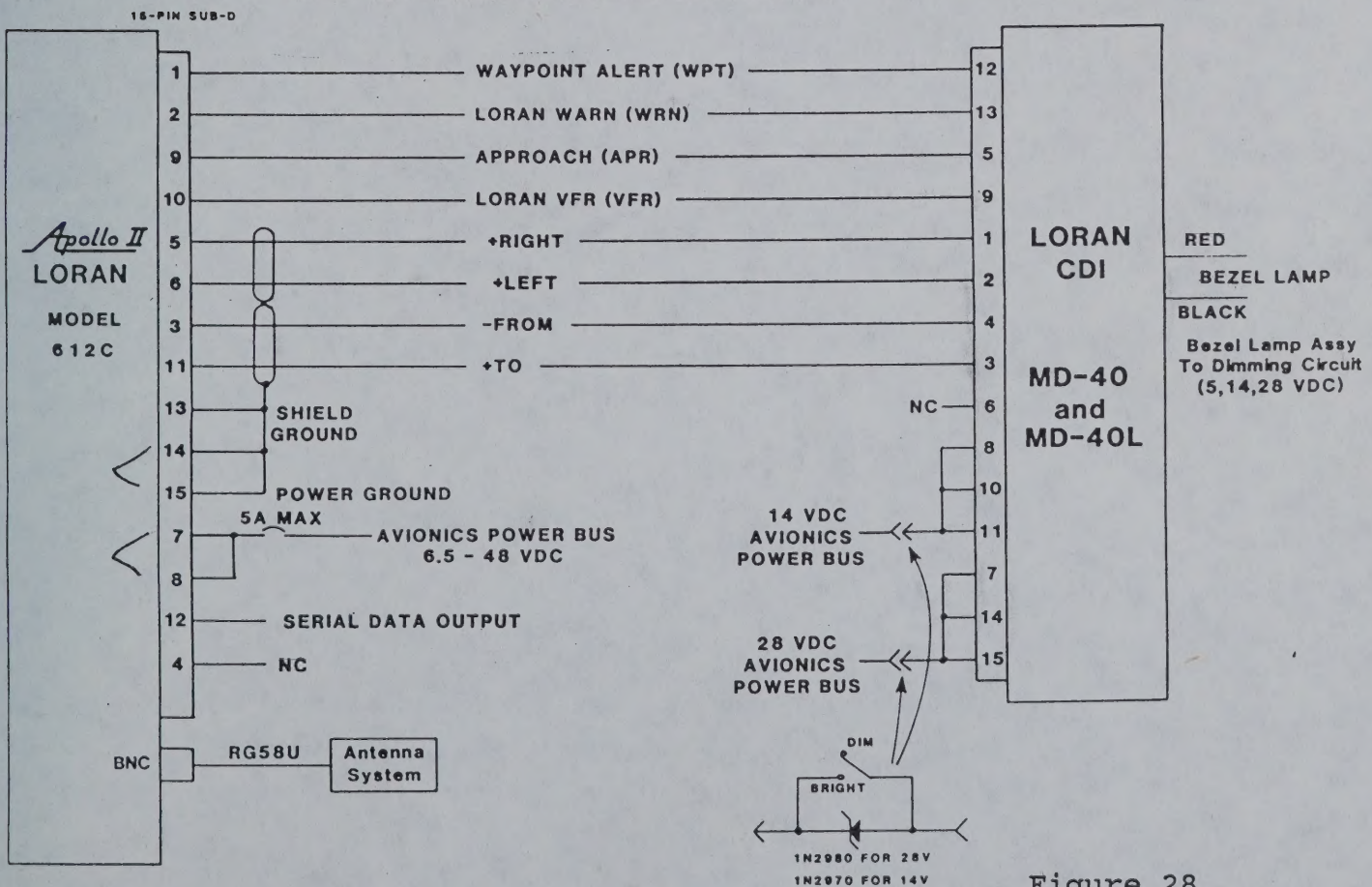


Figure 28

